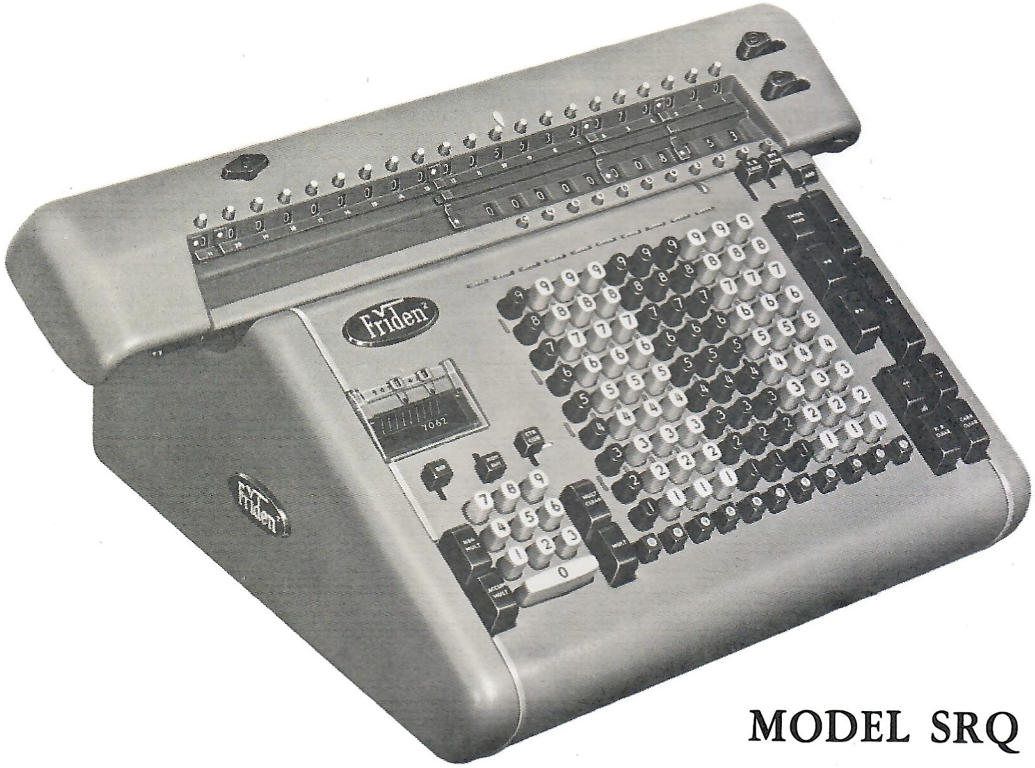
Friden CALCULATING MACHINE

AUTOMATIC SQUARING

MECHANICAL OPERATIONS MANUAL



MODEL SRQ

Friden, Inc.

SAN LEANDRO, CALIFORNIA

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PREFACE

The SRQ machine is basically an SRW with an added feature of automatic squaring. Either feature, automatic squaring, or automatic square root is independent of the other.

The function of squaring a number is simply multiplication of one factor by the same factor. For example, 10^2 is 10 x 10 = 100, 12^2 is 12 x 12 = 144, etc. This is accomplished automatically on the SRQ machine by entering one factor on the main keyboard and depressing one of the multiplier operating keys (Mult., Accum. Mult., or Neg. Mult.).

Automatic squaring of any number selected in the main keyboard is accomplished by the consecutive multiplication of that number by the selected digit or zero in each of the ten columns of the keyboard. For example, if the number to be squared is 125, the ten keyboard columns actually contain 0000000125 and the automatic multiplication process is 5 x 125, 2 x 125, 1 x 125 and the seven columns containing zero continue to multiply the 125 x 0 until all ten columns have been sensed. The answer appearing in the product dials will be 15,625.

The factor entered on the main keyboard is transferred to the #1 segment of the mult unit, one figure at a time beginning with the first column (extreme right) and ending with the 10th column (extreme left). In other words, each column of the main keyboard must be transferred to the mult unit whether it contains a selected digit or a zero.

In addition to the standard parts that operate during automatic multiplication, certain parts have been added for controlling the squaring operation. These parts are conditioned so that the squaring operation will function automatically if one of the mult operating keys is depressed with no digits selected in the mult unit. The selection of a single digit in the mult unit will disable the parts controlling the squaring operation and the normal automatic multiplication will take place when a mult control key is depressed.

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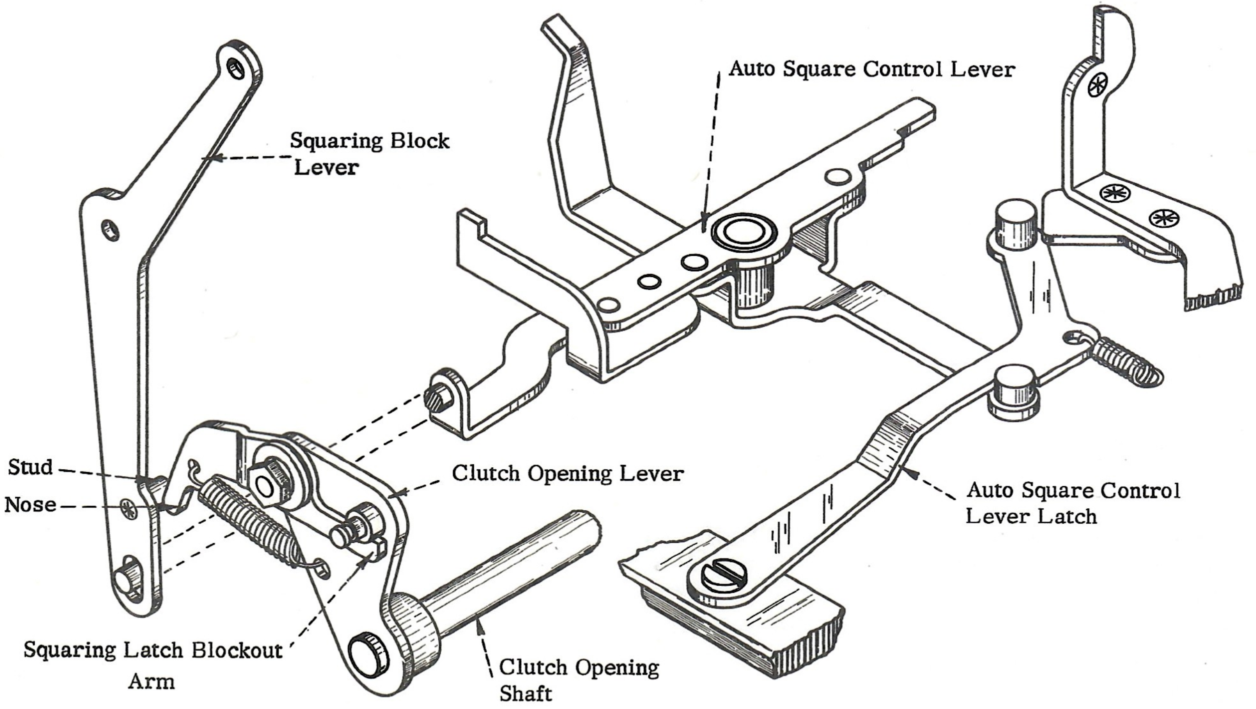

Auto Square Control Lever
Squaring Block Lever
Stud
Nose
Clutch Opening Lever
Auto Square Control Lever Latch
Squaring Latch Blockout Arm
Clutch Opening Shaft

AUTO SQUARE CONTROL LEVER:

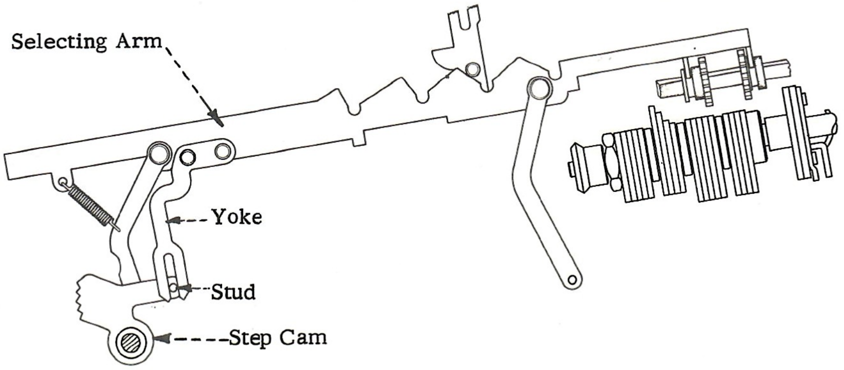
In addition to the normal functions of positive, negative, or accumulate multiplication operations, the multiplier unit is used for automatic squaring. However, no separate auto-square control key is provided nor required.

The control between normal multiplication and automatic squaring is determined by whether or not the auto-square control lever (shown in the latched position) is latched or delatched. For example, if the operation desired is to be a normal multiplication, the operator enters one factor on the main keyboard and the other factor on the multiplier keyboard and depresses one of the multiply keys.

Since the figure, or figures, selected in the multiplier keyboard causes the multiplier unit to escape one position for each figure selected, the first such selection to escape the multiplier unit allows the unit restore lever to contact the roller on the auto-square control lever latch and delatch the auto-square control lever. The left end of the auto-square control lever is spring urged in the forward direction, and a stud on the end of this lever actuates the squaring-block lever so that the lower end of the squaring-block lever moves forward and the upper end rearward. Certain parts (not shown) connected to the upper end of the squaring-block lever are moved rearward to disable the automatic squaring feature.

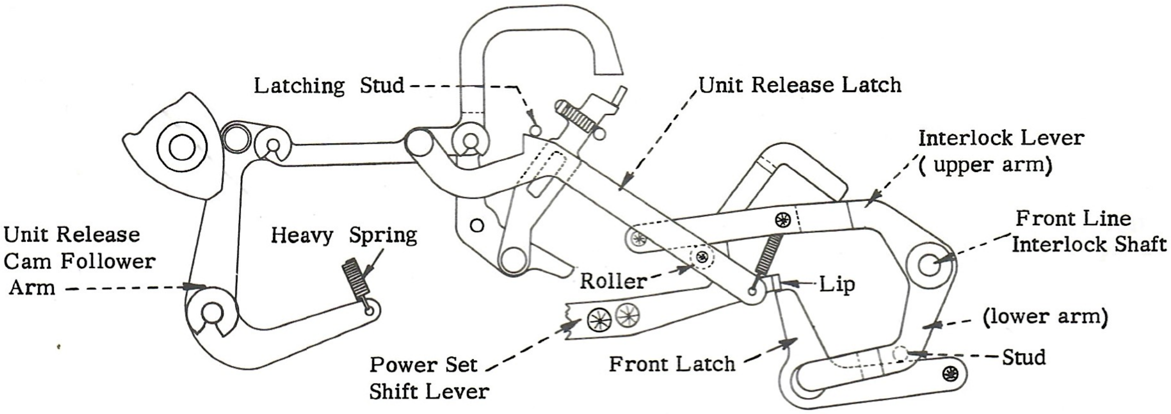
When one of the multiply keys is depressed, the rotation of the clutch opening shaft positions the "nose" on the squaring-latch blockout arm behind the stud on the squaring-block lever and holds the squaring-block lever in the disabled position until the multiplication operation is completed.

If, however, a squaring operation is desired, the number to be squared is entered on the main keyboard, but no selection is made in the multiplier keyboard. Therefore, the auto-square control lever latch is not actuated by the unit restore lever; the auto-square control lever does not get delatched and the squaring-block lever remains stationary. Now when one of the multiply keys is depressed, the rotation of the clutch opening shaft positions the "nose" on the squaring-latch blockout arm in front of the stud on the squaring-block lever. This prevents the auto-square control lever from delatching when the multiplier unit is automatically released against the fixed stop and holds the squaring-block lever stationary until the squaring operation is completed.



SELECTING ARMS AND STEP CAMS:

A yoke connected near the front of each selecting arm is positioned over the stud on its respective step cam. The step cams for the 1 to 5 selecting arms have 5 teeth and the step cams for the 6 to 9 selecting arms have 4 teeth. Therefore, the depression of any main keyboard numeral key will not only cause the selecting arm to position its selecting gear, but will also pivot the step cam so that a tooth on the step cam will be in a position relative to the figure selected.

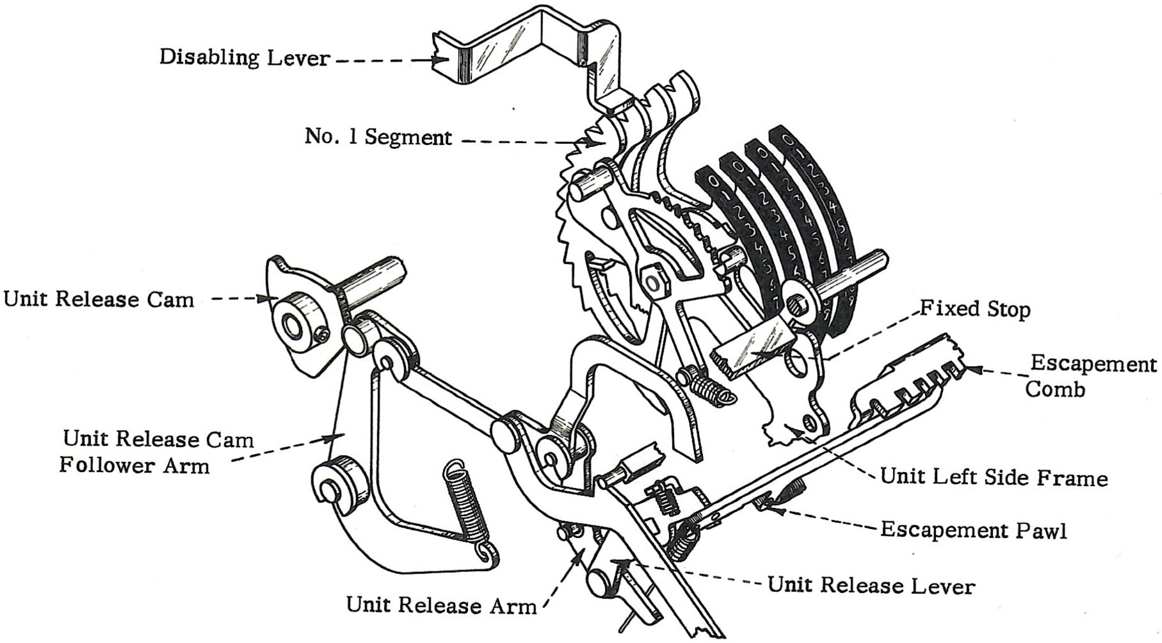


DELATCHING OF FRONT LATCH AND MULT UNIT RELEASE LATCH:

The following mechanical operations are described in sequence as the drive shaft is rotated by hand crank. Knowledge of the basic machine is assumed and reference to the basic parts in the drawing accompanying the write-up is used only where necessary to show the relationship of the basic part or parts to the operation of the squaring feature.

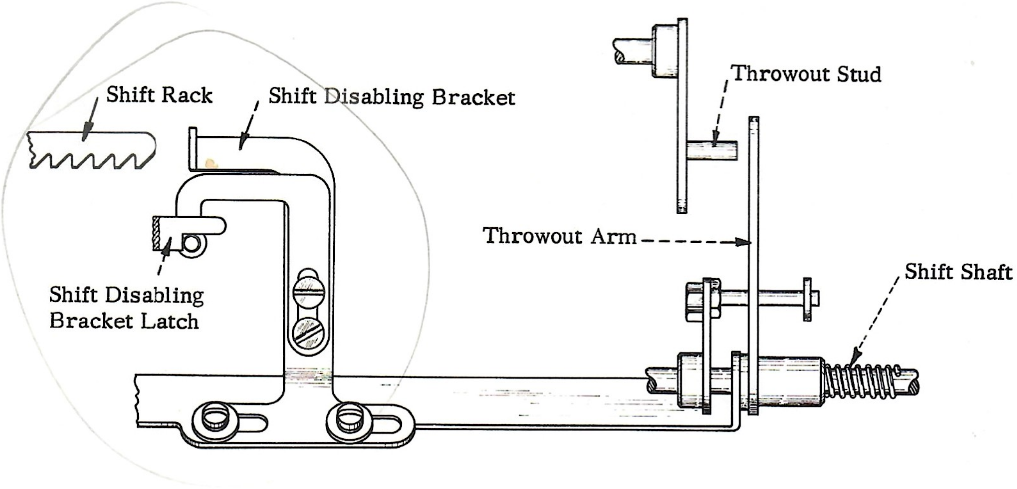
With the figure to be squared pre-set in the main keyboard and the mult unit in "home" position, depress the mult key and rotate the drive shaft until the front line interlock shaft is rotated to cause the interlock lever to move downward as shown. This will cause:

1. The stud on the lower arm to move the front latch from under the lip of the power set shift lever.
2. The upper arm to contact the roller on the unit release latch and move the unit release latch off its latching stud. The unit release latch assembly is spring urged rearward by the heavy spring on the cam follower arm.



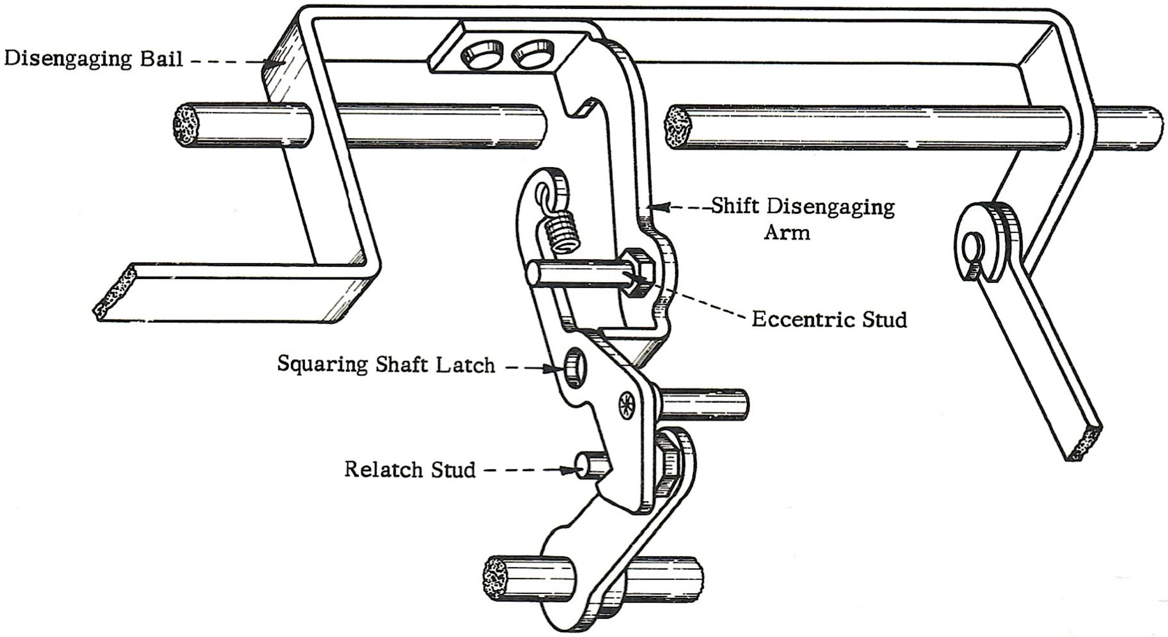
MULT UNIT RELEASE TO FIXED STOP:

When the unit release cam follower arm moves rearward, it pivots the unit release arm to raise the unit release lever against the tail on the escapement pawl. The escapement pawl is disengaged from the escapement comb and the mult unit is spring urged against the fixed stop. The fixed stop position is not quite two full teeth and the reason for this is to allow for a timing condition in the first unit shift and the selection and release of the #1 segment.



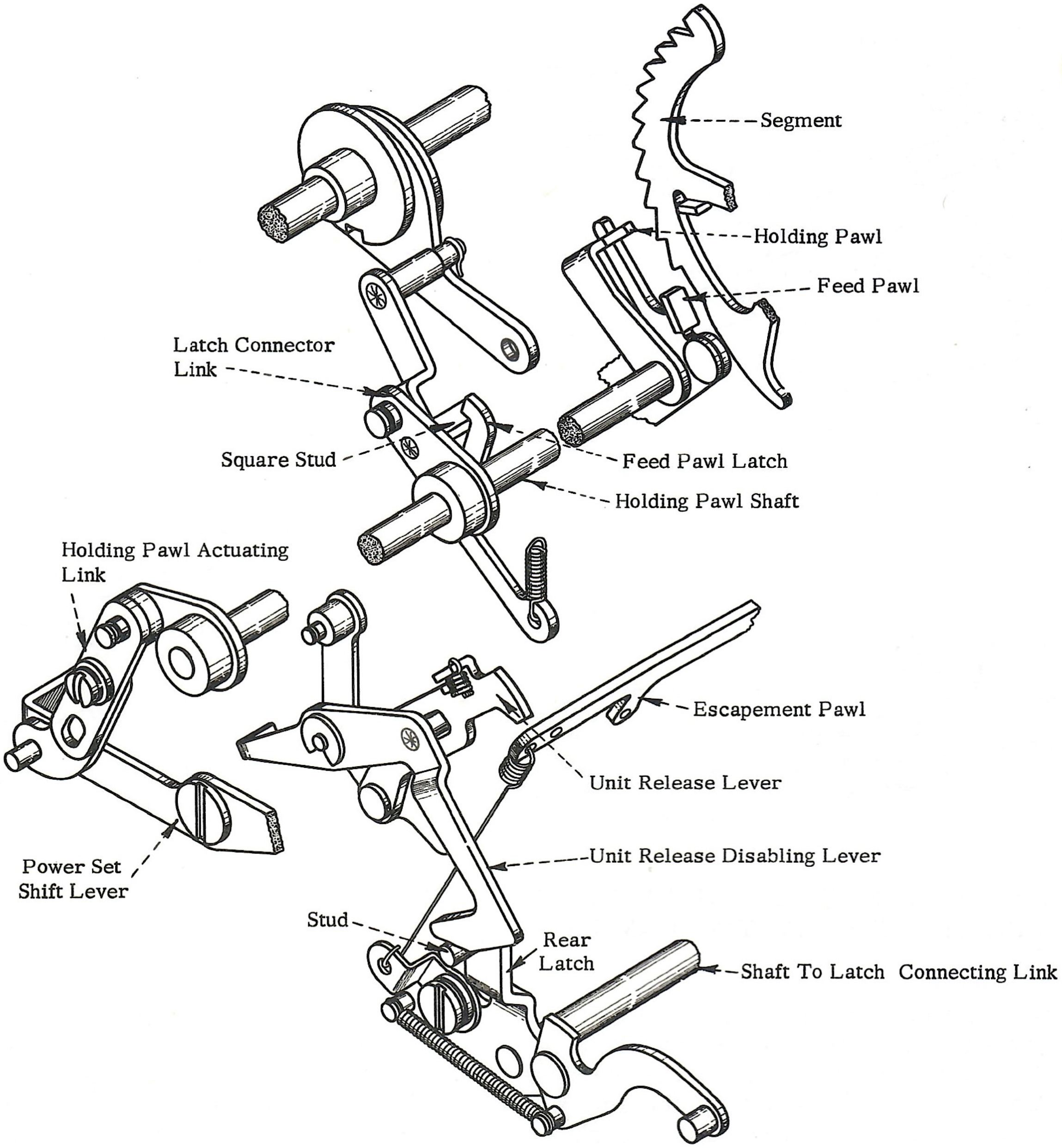
SHIFT DISABLING BRACKET LATCH:

Movement of the unit against the fixed stop is caused by the spring action on the unit restore lever. The shift disabling bracket is latched by the shift disabling bracket latch however, and will remain latched until later in the squaring operation sequence. This to prevent a carriage shift out of first position when the override occurs and the shift shaft is delatched to initiate the squaring operation.



DELATCHING THE SQUARING SHAFT LATCH AND POSITIONING THE POWER SET CAM:

Continued rotation of the drive shaft will shift the carriage to the first position and clear the carriage dials. When the override action occurs, the movement of the disengaging bail causes the eccentric stud on the shift disengaging arm to raise the squaring shaft latch off of its relatch stud. The bail also disengages the left shift engaging link and the carriage clear link.



DELATCHING THE SQUARING SHAFT LATCH AND POSITIONING THE POWER SET CAM: (Cont'd.)

At the same time, movement of the disengaging bail also causes the rear latch to be moved from under the power set shift lever and the power set shift lever drops. This action causes:

1. A stud on the rear latch to contact the tail on the unit release disabling lever and move the unit release lever rearward from under the escapement pawl.

2. The throwout lever to move the power set cam into position over the delatch and relatching levers, and position the cam in front of the roller on the power-set levers.

3. The holding pawl actuating link to raise, which normally allows the holding pawl shaft to rotate and engage the feed pawl and holding pawl with the segment. However, the segment is not ready to be fed out and therefore, the holding pawl shaft is latched by the feed pawl latch engaging the square stud on the holding pawl latch connector link.

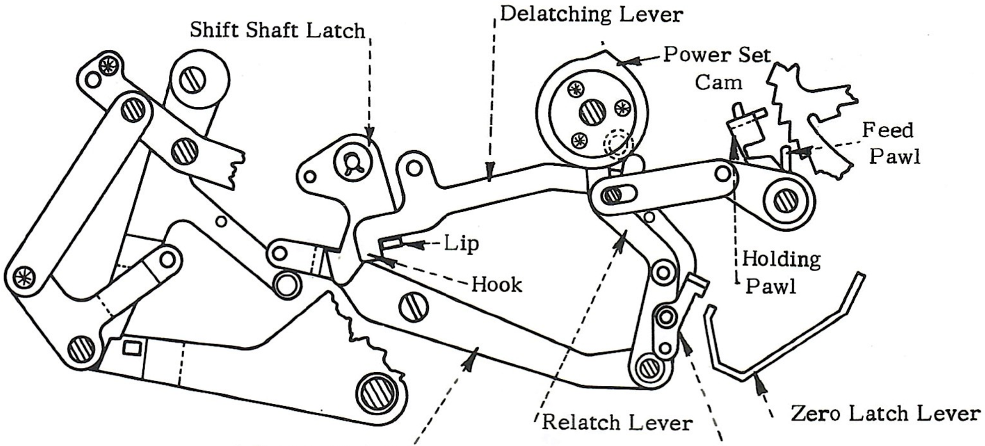


FIG. A

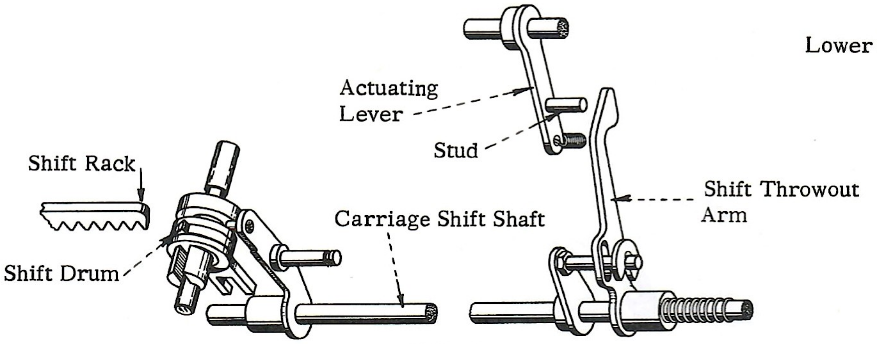


FIG B

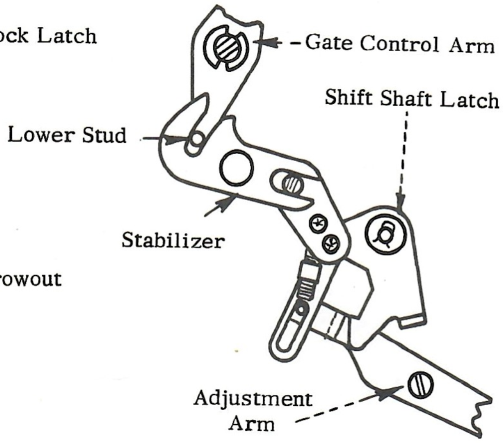


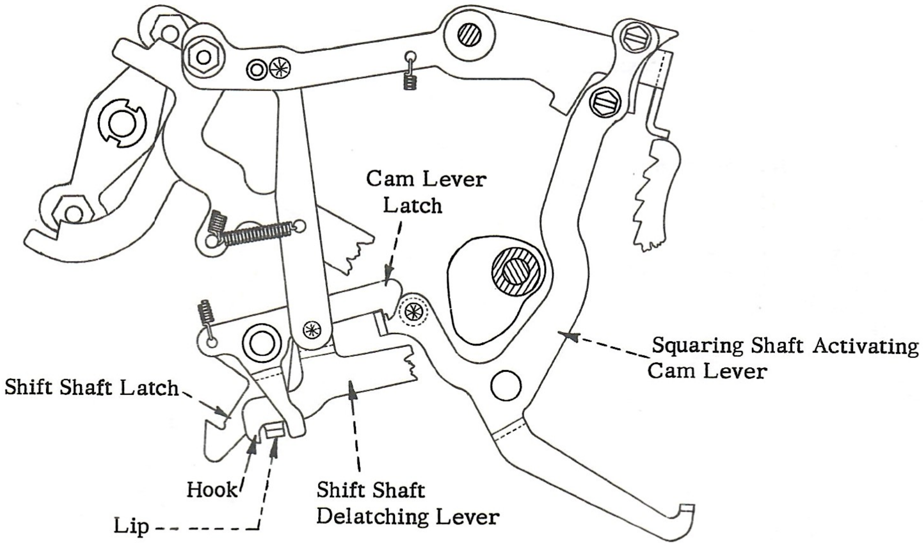
FIG. C

DELATCHING THE SHIFT SHAFT LATCH AND THE SQUARING SHAFT ACTIVATING CAM LEVER:

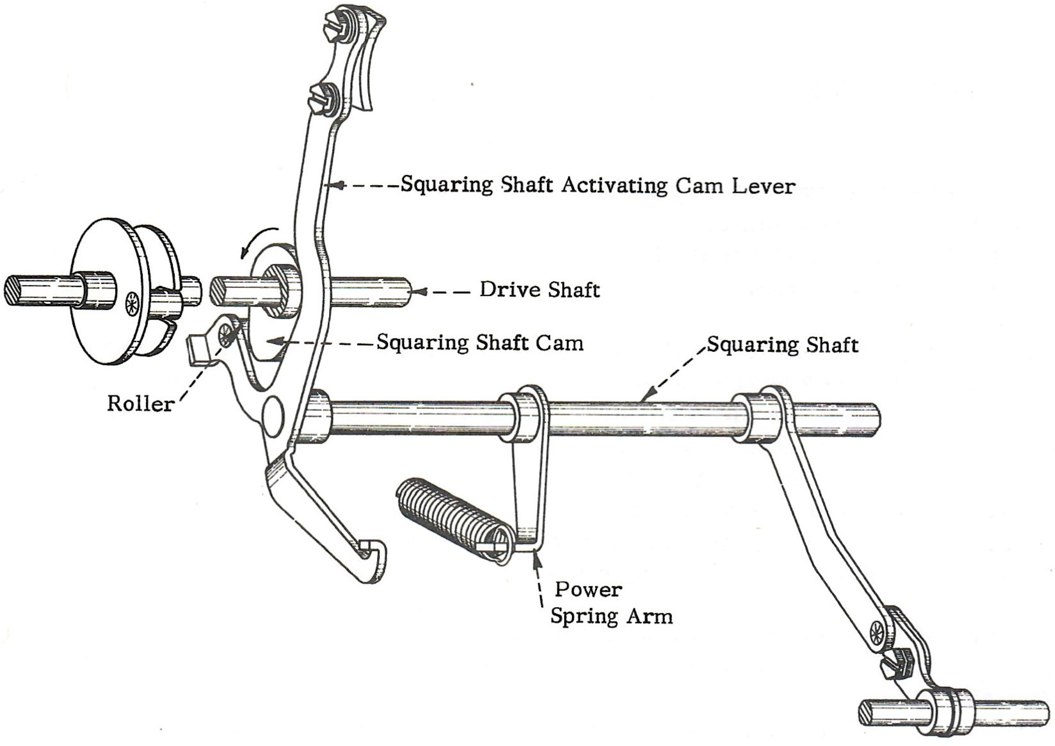
With the mult unit positioned against the fixed stop, the lip on the disabling lever is positioned over the #1 and #2 mult segments. Since the segments are at zero, the hook of the shift shaft delatching lever (Fig. A) is positioned over the lip of the shift shaft latch. As the delatching lever is moved to the front by the action of the roller on the power set cam, the hook of the shift shaft delatching lever pulls the shift shaft latch from under the adjustment arm. When this occurs the adjustment arm drops by spring action to cause:

1. The adjustment arm (Fig.A) disables the power set latch from the latching stud on the power set lever.
2. The carriage shift shaft (Fig. B) is rotated by spring to cause:
   a. the raising of the shift drum to position the shift tooth into the shift rack and,
   b. the shift throwout arm to move rearward alongside the stud on the actuating lever.
3. The adjustment arm positions the stabilizer (Fig. C) over the lower stud of the gate control arm.
4. The adjustment arm causes the relatch lever (Fig. A) to move rearward and through a link disables the holding pawl and feed pawl from the segment. At the same time, the rearward movement of the relatch lever pulled the zero block latch away from the lip on the zero latch lever.

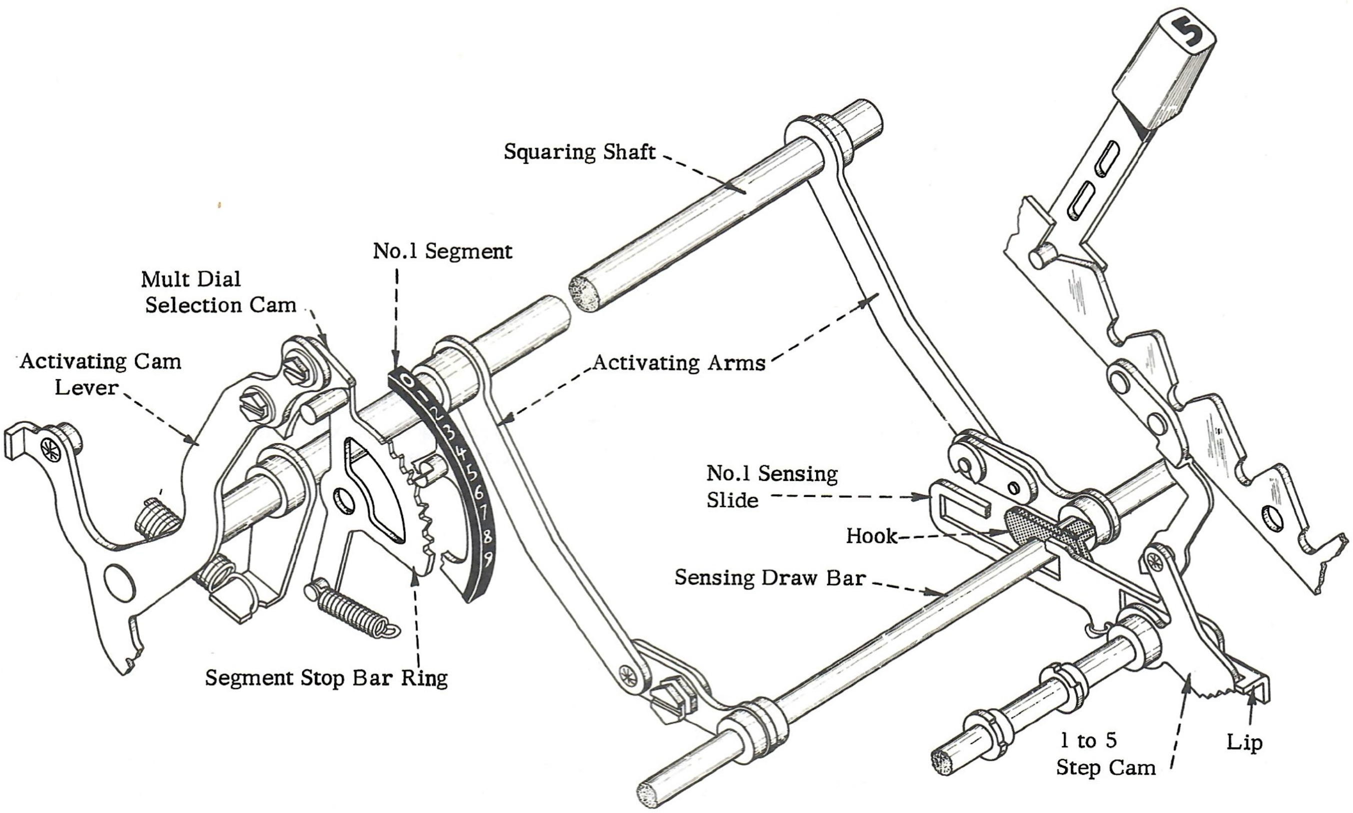
DELATCHING THE SHIFT SHAFT LATCH AND THE SQUARING SHAFT ACTIVATING CAM LEVER: (Cont'd.)


Cam Lever Latch
Squaring Shaft Activating Cam Lever
Shift Shaft Latch
Hook
Lip
Shift Shaft Delatching Lever

Further movement of the hook on the shift shaft delatching lever pulls the lip on the shift shaft latch against the tail on the squaring shaft activating cam lever latch and raises the latch off of the lip on the squaring shaft activating cam lever. Therefore, each time the shift shaft is delatched to cause a shift cycle, the squaring shaft activating cam lever is delatched. The squaring shaft is not released, however, unless the squaring shaft latch has been previously released. (See "Delatching the Squaring Shaft" page 4).



The squaring shaft is spring actuated by the power spring (approximately 5 lbs pull) connected to the power spring arm. As the drive shaft continues to rotate, the roller on the activating cam lever follows the squaring shaft cam and allows the squaring shaft to rotate smoothly.

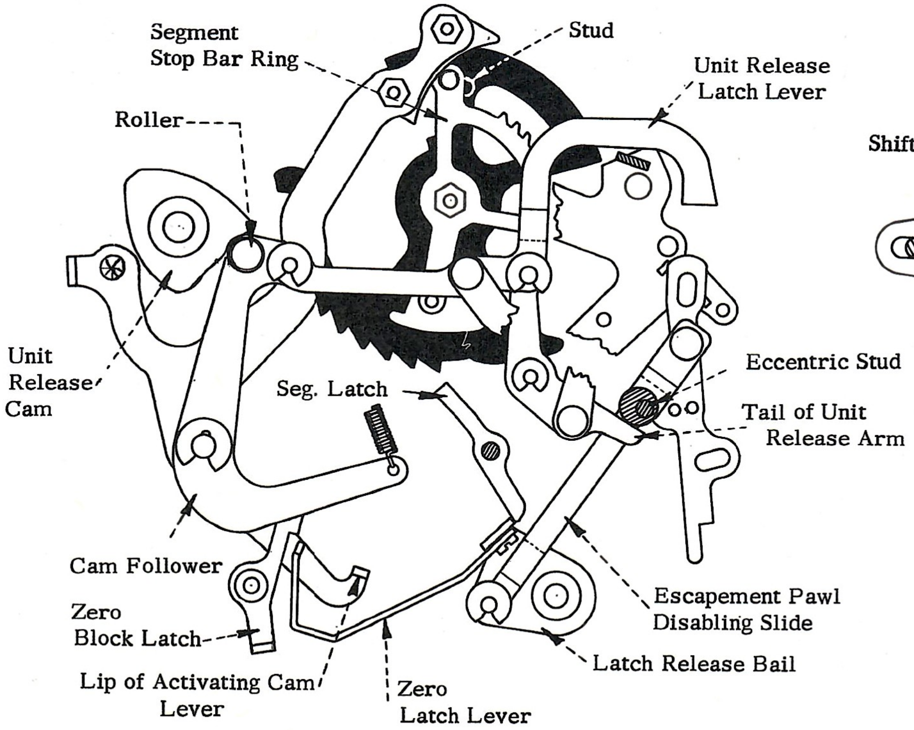


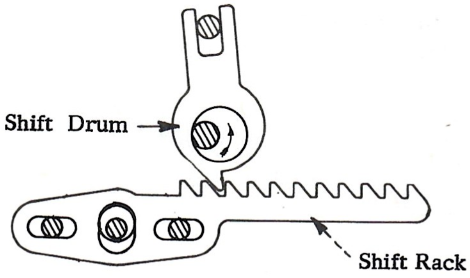
POSITIONING THE SEGMENT STOP BAR RING:

Selection of numbers from the keyboard columns to the #1 mult segment occurs in sequence starting with the first column and continuing successively to the tenth column. The step cam for each figure selected in the main keyboard has rotated its 1 to 5 or 6 to 9 step cam to correspond to the selected figure.

As the squaring shaft begins to rotate, the two activating arms pinned to the shaft move rearward. As they move rearward, a sensing draw bar connected between the activating arms sweeps rearward through the slots in the sensing slides. Since the figure in the first keyboard column will be the first selected and multiplied by the #1 mult segment, the home position for the hook on the #1 sensing slide is in the activated position, so that when the sensing draw bar sweeps through the slots in the sensing slides, it will engage the hook and pull the #1 sensing slide rearward. This rotation of the squaring shaft and movement of the sensing slide continues until a lip on the sensing slide contacts a tooth on the 1 to 5 or 6 to 9 step cam.

As the squaring shaft rotates to its selected position, the squaring shaft activating cam lever moves forward and the mult dial selection cam contacts the stud on the segment stop bar ring. This causes the stop bar ring to rotate to a position corresponding to the figure selected in the keyboard and in effect is the same as raising a setting pin when one of the mult selection keys is depressed.





UNIT SHIFT - SEGMENT RELEASE - SEGMENT HOLD:

With the shift shaft delatched as previously described, the adjustment arm and relatch lever have moved rearward to delatch the zero latch lever and the shift drum tooth is engaged in the shift rack as shown above. Continued rotation of the drive shaft will cause:

1. The shift drum to rotate and the tooth engaging the shift rack will start pulling the unit to the right.

2. When the unit has just started to move, the roller on the unit release cam follower drops into the low dwell of its cam. This causes the unit release latch lever to move rearward and pivot the unit release arm so that the tail on the arm raises the eccentric stud on the escapement pawl disabling slide. The segment latch release bail connected to the escapement pawl disabling slide swings forward and trips the segment latch for the #1 segment, but misses the latch for the #2 segment. The #1 segment is released and rotates by spring tension until stopped by the stud on the segment contacting the segment stop bar ring.

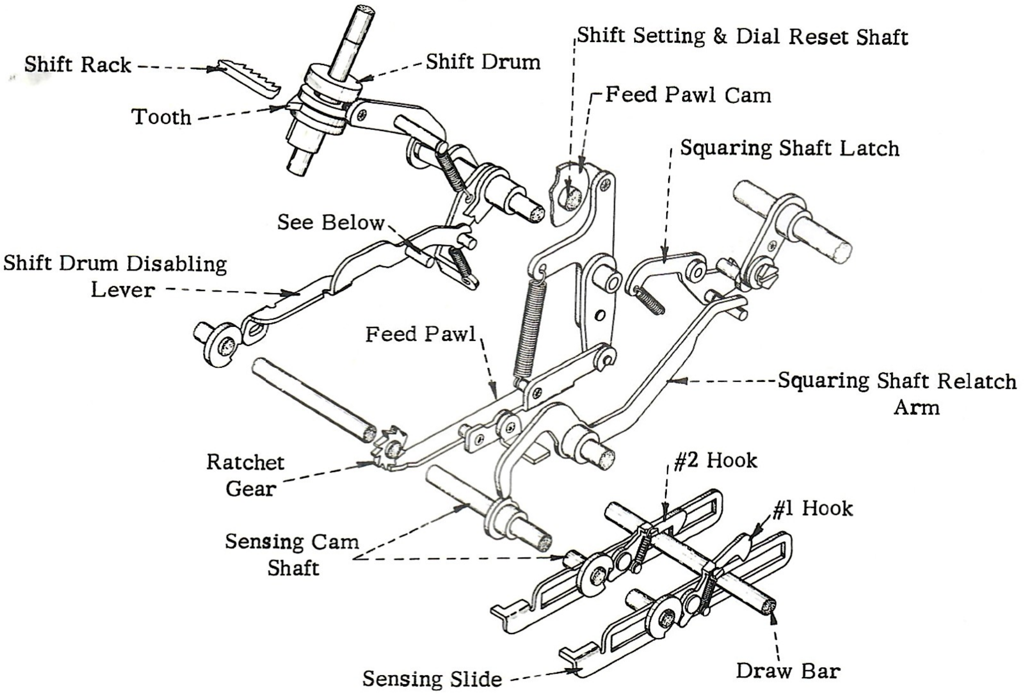
   Note: The unit release cam follower can drop into the low dwell of its cam only after the zero block latch has been moved away from the lip on the zero latch lever by the action of the adjustment arm relatch lever.

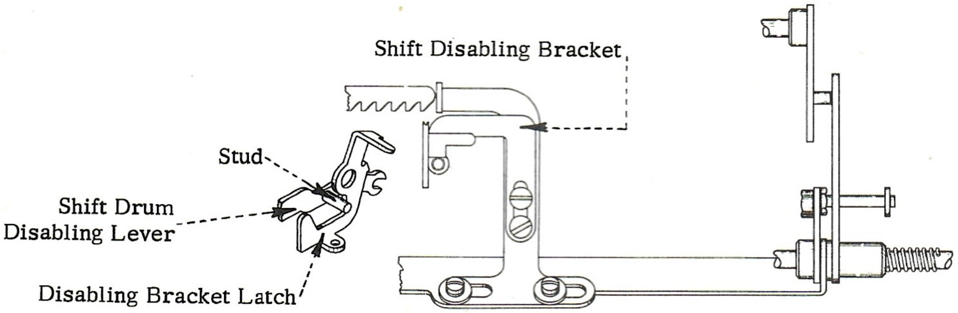
ZERO SELECTION:

If the selection is a zero, the latch release bail is prevented from releasing the segment by the lip on the zero latch lever being blocked by the lip on the activating cam lever.

UNIT SHIFT - SEGMENT RELEASE - SEGMENT HOLD: (Cont'd)

As the unit completes its right shift, the lip on the disabling lever drops off into the space over the #1 segment. When this occurs the rear of the lever raises the hook off the lip of the shift shaft latch and allows the plus gate engaging lever to engage the upper stud of the gate control arm.

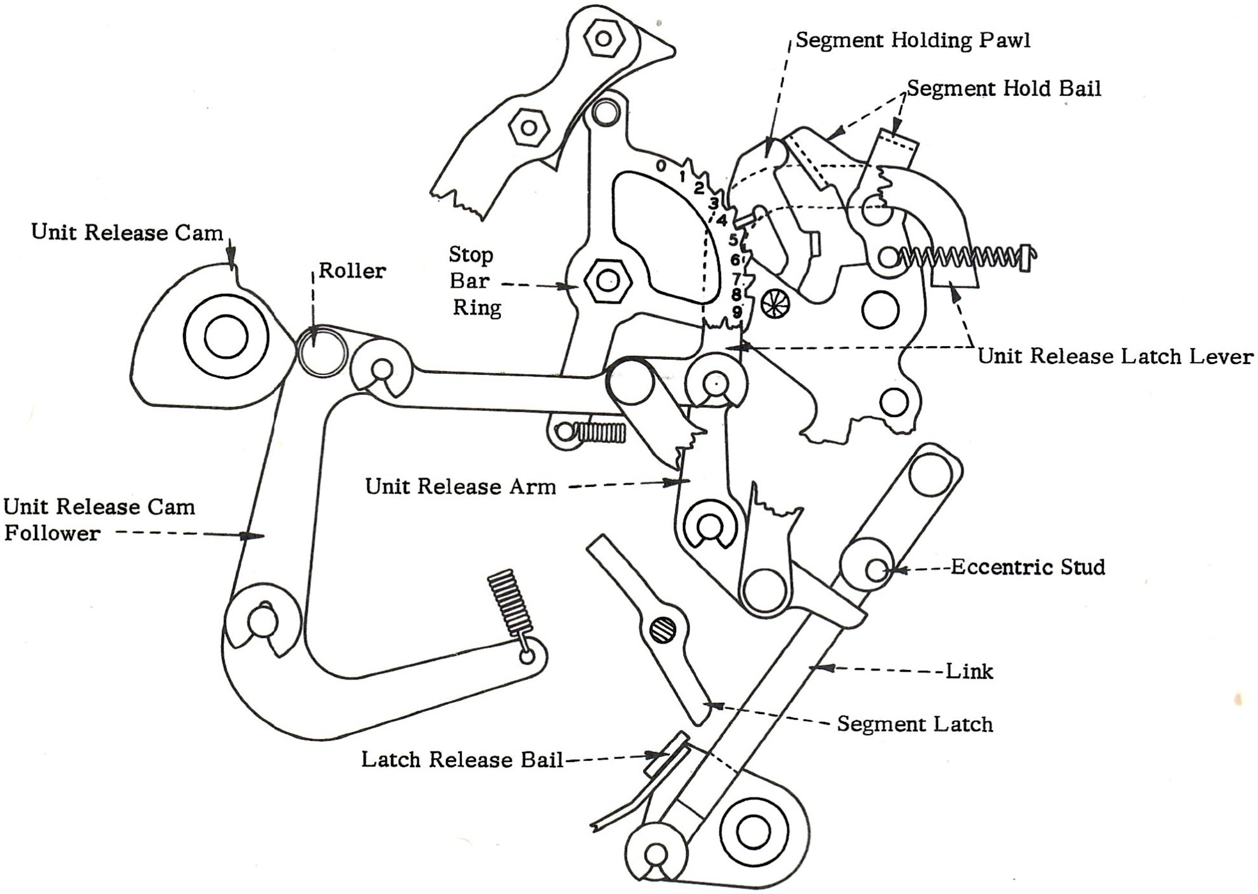




3. The rotation of the squaring shaft and rearward movement of the draw bar allows the sensing cam shaft feed pawl lever to be positioned against a tooth on the ratchet gear. Continued rotation of the drive shaft will rotate the feed pawl cam on the shift setting and dial reset shaft and the sensing cam shaft will be rotated one tooth position which causes:

   a. The shift drum disabling lever to be cammed rearward to disengage the shift drum tooth from the shift rack.
   b. If the selection in the first order is any number other than zero, the stud on the shift drum disabling lever will contact the shift disabling bracket latch and unlatch the shift disabling bracket to allow the shift throwout arm to move against the stud on the shift actuating lever. Note: If the selection is a zero, the draw bar will contact the shift disabling bracket latch and unlatch the shift disabling bracket.
   c. The hook on the #1 sensing slide to be restored.
   d. The hook on the #2 sensing slide to be positioned for the next selection.
   e. The tail on the squaring shaft relatch arm to be cammed downward against the stud on the squaring shaft latch. The squaring shaft latch is then held in the delatched position until the sensing cam shaft has rotated through all ten positions and brought the dwell in the squaring shaft relatch arm cam to "home" position.

UNIT SHIFT - SEGMENT RELEASE - SEGMENT HOLD: (Cont'd.)

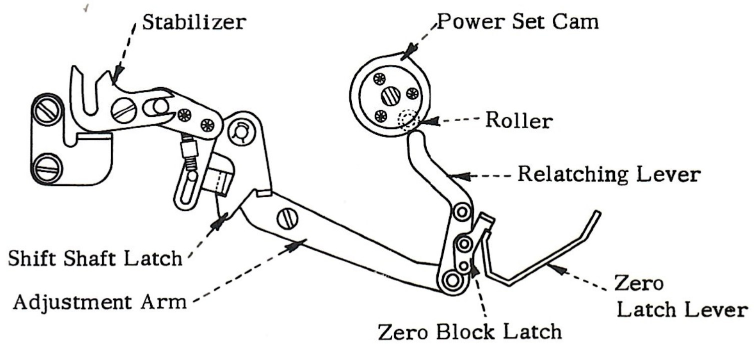


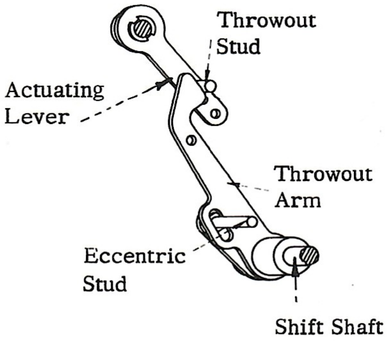
Continued rotation of the drive shaft will cause: (Cont'd.)

4. The medium lobe of the unit release cam to contact the roller on the unit release cam follower. As the cam follower is moved forward, it pushes the unit release latch lever forward and this action causes:

   a. The unit release arm to pivot so that the tail moves away from the eccentric stud and lowers the link to swing the latch release bail away from the segment latch.
   b. The segment hold bail is spring urged against the segment holding pawl and engages the holding pawl into a tooth on the segment stop bar ring. The teeth on the segment stop bar ring correspond to the digits 1 through 9.

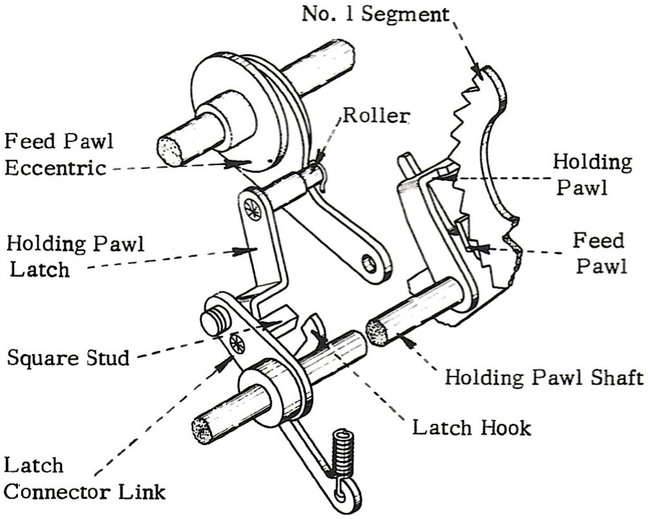
POSITIONING OF SEGMENT FEED PAWL:





Continued rotation of the drive shaft causes the roller on the power set cam to contact the relatch lever. This results in:

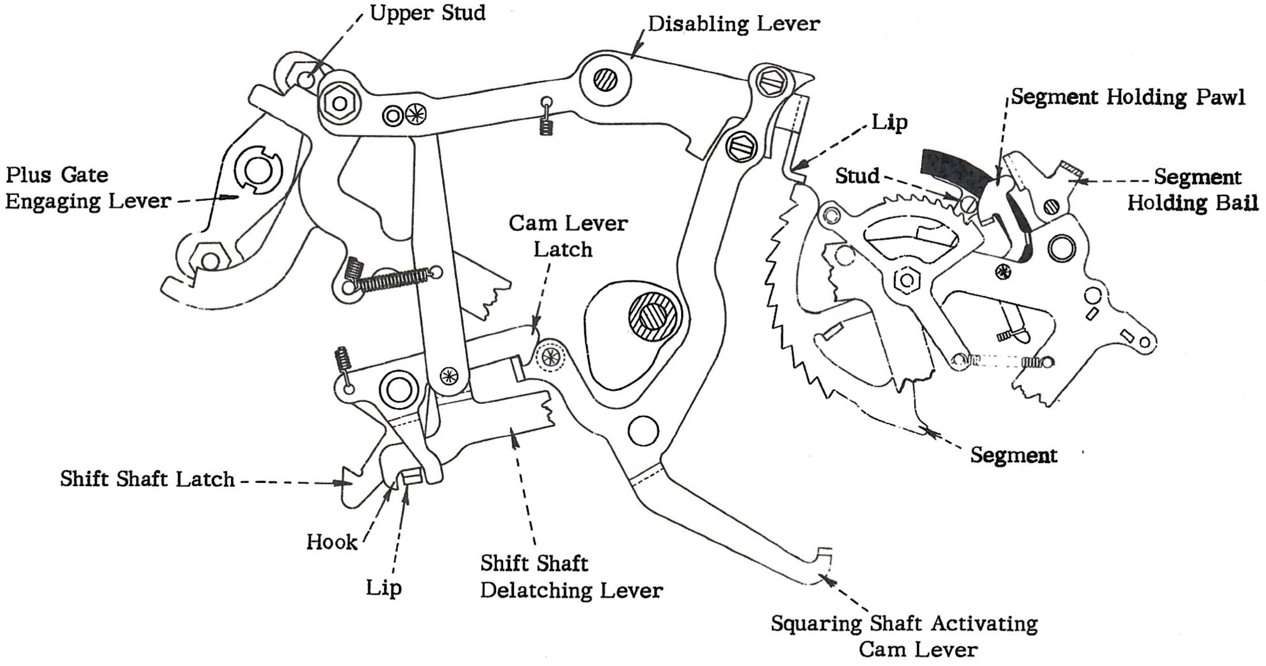
1. Restoring the stablizer and latching the adjustment arm.
2. Restoring the carriage shift shaft and the shift throwout arm can now move over the stud on the actuating lever.
3. Restoring the zero block latch over the zero latch lever to block the zero latch lever and latch release bail during the last feed up of the segment.



As the drive shaft continues to rotate,the feed pawl eccentric contacts the roller on the holding pawl latch and moves the latch hook away from the square stud on the holding pawl latch connector link. The forward movement of the holding pawl brings the feed pawl into position for feeding out the #1 segment.

NOTE: In a squaring operation, when the selection is a high number such as 8's or 9's, the momentum of the #1 segment against the stud on the stop bar ring tends to cause the segment to bounce away from the stop. To prevent the possiblilty of the holding pawl coming in and catching a tooth on the segment one tooth lower than the selection, the latch hook on the holding pawl latch engages the square stud on the latch connector link to delay the forward movement of the holding pawl until the #1 segment has fully settled against the stop bar ring.

As a point of general information in connection with this timing problem, it was also found necessary to retard the feed pawl eccentric 47 degrees. When operating the machine by hand crank, the timing may not be apparent, however, high speed movies and engineering studies show this timing as being necessary when the machine is operated under power.



FEED OUT OF SEGMENT:

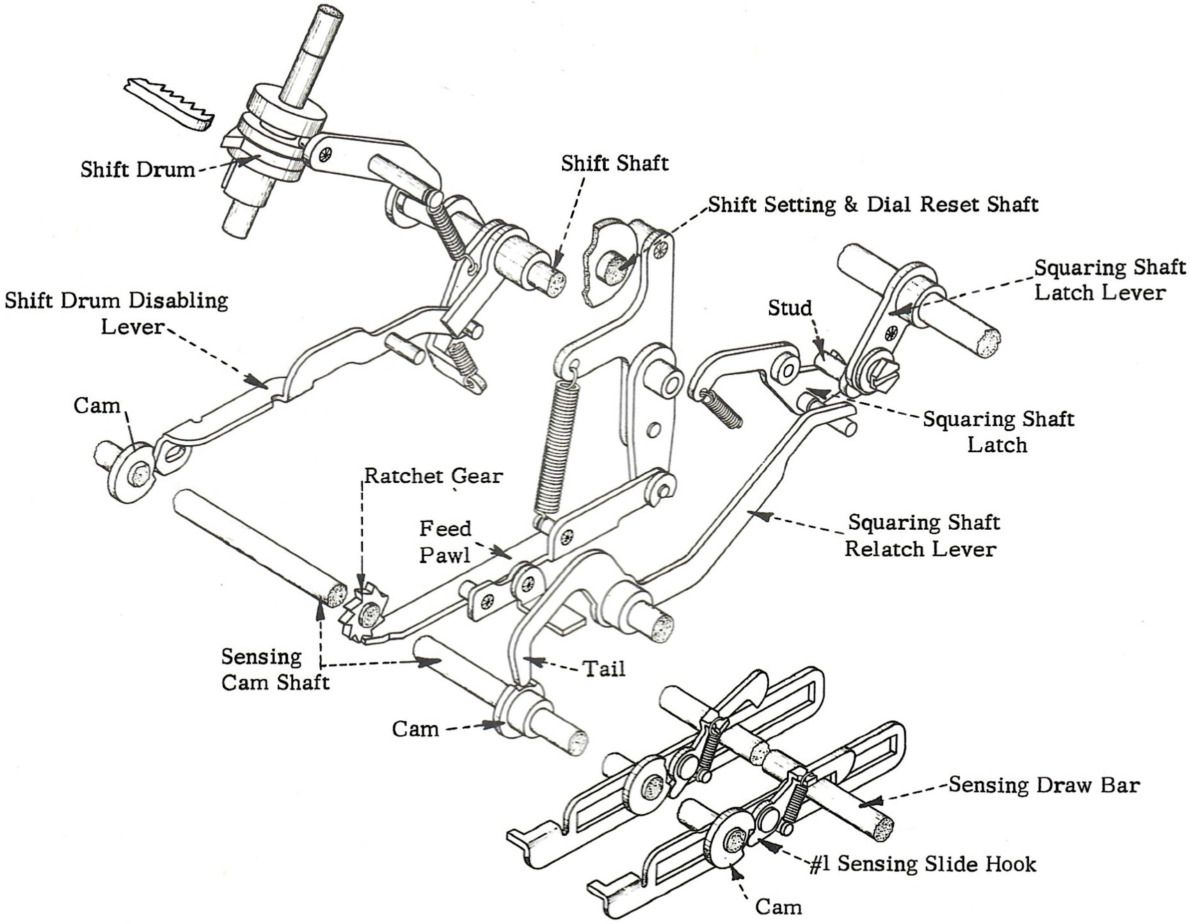
Continued rotation of the drive shaft will cause the feed pawl to feed out the segment one tooth for each cycle of the drive shaft, until the segment feeds to zero. Each cycle corresponding to the segment feed will add the main keyboard figure one time into the upper dials and will rotate the counter dial one digit. As the segment is fed to zero, the stud on the #1 segment contacts the segment holding pawl and restores the segment holding bail. When the segment dial reaches the zero position, the lip on the disabling lever is raised. This causes:

1. The rear of the lever to position the hook of the shift shaft delatching lever over the lip of the shift shaft latch.

2. The rear of the disabling lever to disengage the plus gate engaging lever from the upper stud. When this occurs, the add-subtract gate is held in position by the cycle lock pin against the cycle lock disc until the disc rotates to the cutout.

Further rotation of the drive shaft will cause the hook of the shift shaft delatching lever to pull the shift shaft latch from under the adjustment lever and to delatch the squaring shaft activating cam lever. The carriage shift shaft will rotate to cause the carriage right shift and the squaring shaft will rotate to cause the selection in the next column of the keyboard to be selected in the mult unit. The unit is prevented from shifting by the shift drum disabling lever.

This completes the mechanical operations for the selection and feed out of the first keyboard column. The sequence of operation for the remaining keyboard columns is the same as previously described.



ROTATION OF SENSING CAM SHAFT TO "HOME" POSITION:

When the 10th column is sensed in the #1 mult segment by the rotation of the squaring shaft pulling the sensing draw bar and the sensing slide against the tooth on the step cam, the sensing cam shaft feed pawl is spring urged in position to engage a tooth on the sensing cam shaft ratchet gear. Continued rotation of the drive shaft will rotate the shift setting and dial reset shaft and cause the pawl on the sensing cam shaft feed pawl lever to rotate the sensing cam shaft one final tooth space to its "home" position. This action will cause:

1. The cam for the shift drum disabling lever to rotate and allow the shift drum disabling lever to restore to home position. The shift drum remains disengaged by the lever on the shift shaft.

2. The cam for the #1 sensing slide hook to rotate and position the #1 hook into position for the next squaring operation.

3. The cam for the squaring shaft relatch lever to rotate and allow the tail on the relatch lever to drop into the notch on its cam. As the squaring shaft restores to home position the squaring shaft latch engages the stud on the squaring shaft latch lever.

4. The cam for the #10 sensing slide hook to rotate and restore the #10 sensing slide hook to its home position.

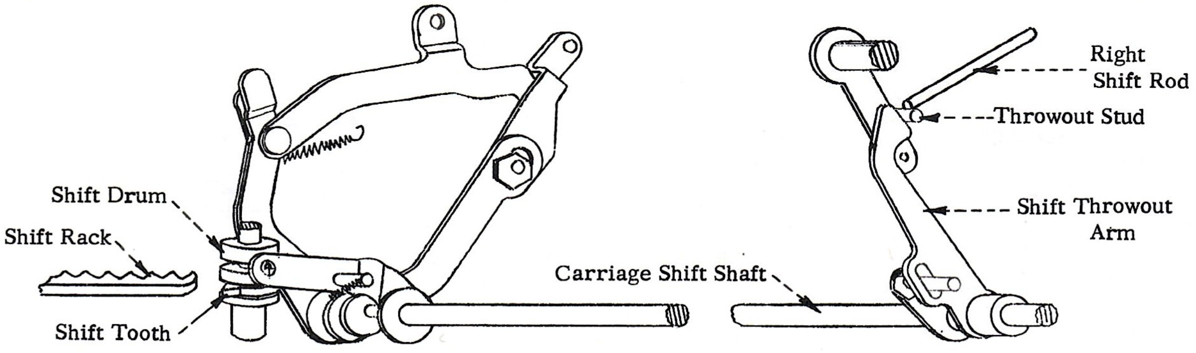


FIG. A

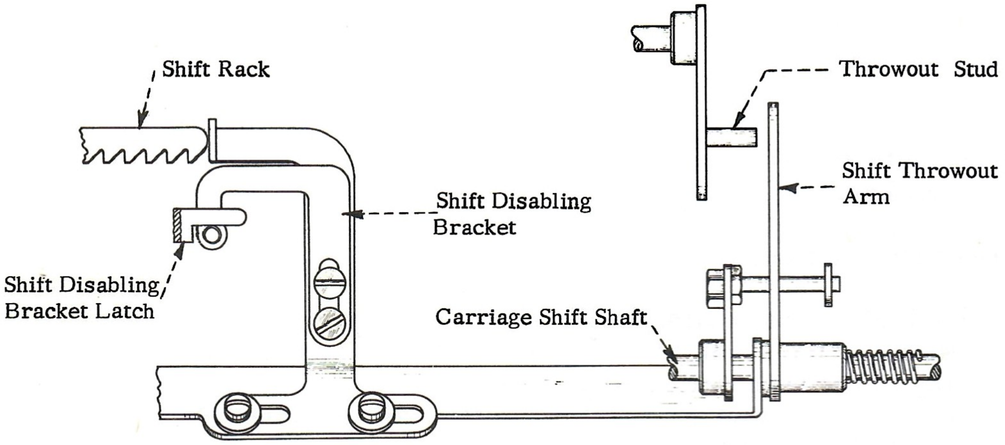


FIG. B

UNIT SHIFT TO HOME POSITION:

Continue to rotate the drive shaft until the 10th keyboard selection in the #1 segment has fed out to zero. When the disabling lever is raised by the segment, the same actions for delatching the shift shaft and the squaring shaft activating cam follower occur as mentioned before. The squaring shaft does not drop however, because it is held by the squaring shaft latch.

The carriage shift shaft is rotated by spring to:

1. Actuate the shift throwout arm, Fig. A, against the throwout stud and engage the right shift rod for a right shift.

2. Raise the shift drum, Fig. A, to position the shift tooth into the shift rack. As the unit shifts it causes:

   a. The end of the shift rack Fig. B, to move the shift disabling bracket to the right and the shift disabling bracket is relatched on its latch.
   b. The shift throwout arm is moved off the throwout stud.
   c. The unit moves the shift trip segment under the lip on the disabling lever so that one more unit shift will be made.

UNIT SHIFT TO HOME POSITION: (Cont'd).

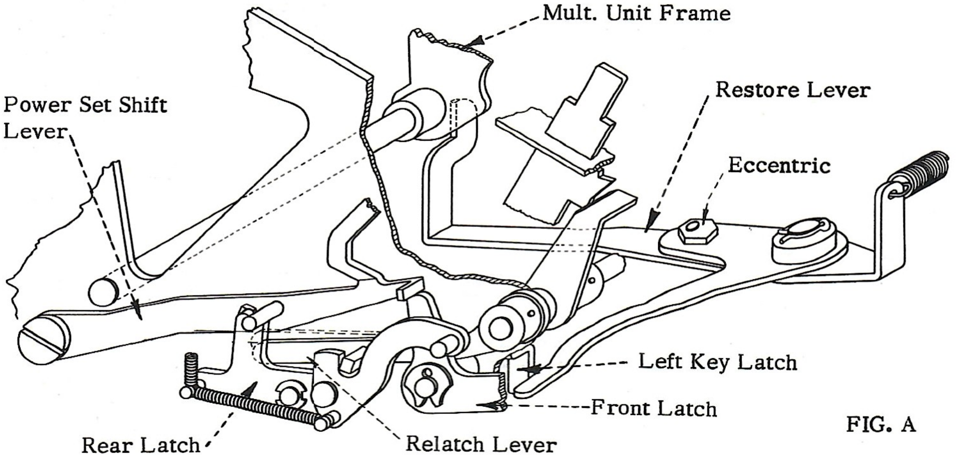


FIG. A

When the last unit shift occurs, the unit shifts past home position and the following actions occur:

1. The unit contacts the restore lever and moves it against the left key latch to restore the depressed mult key.

2. The key restoring causes:

   a. The delatch of the oscillating latch.
   b. The restore of the front line interlock shaft, the release of the front latch, and the positioning of the keyboard clear link.
   c. The release of the clutch release dog to allow the clutch to close and the switch to open at the end of the drive shaft cycle.
   d. The squaring latch blockout arm to restore (Fig. B).

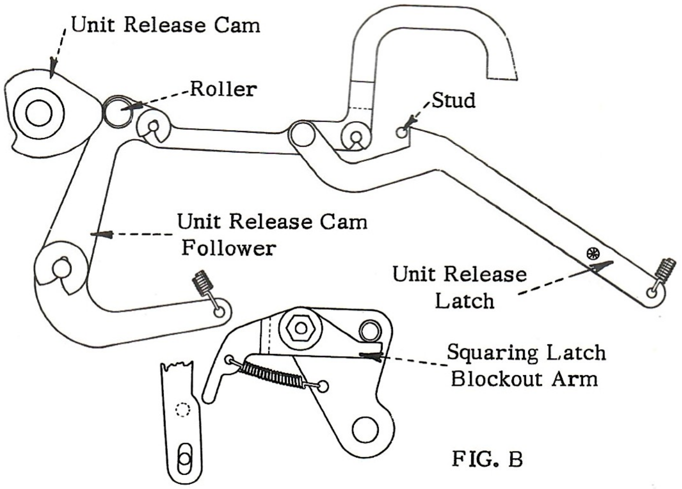
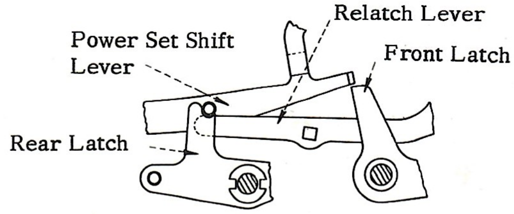


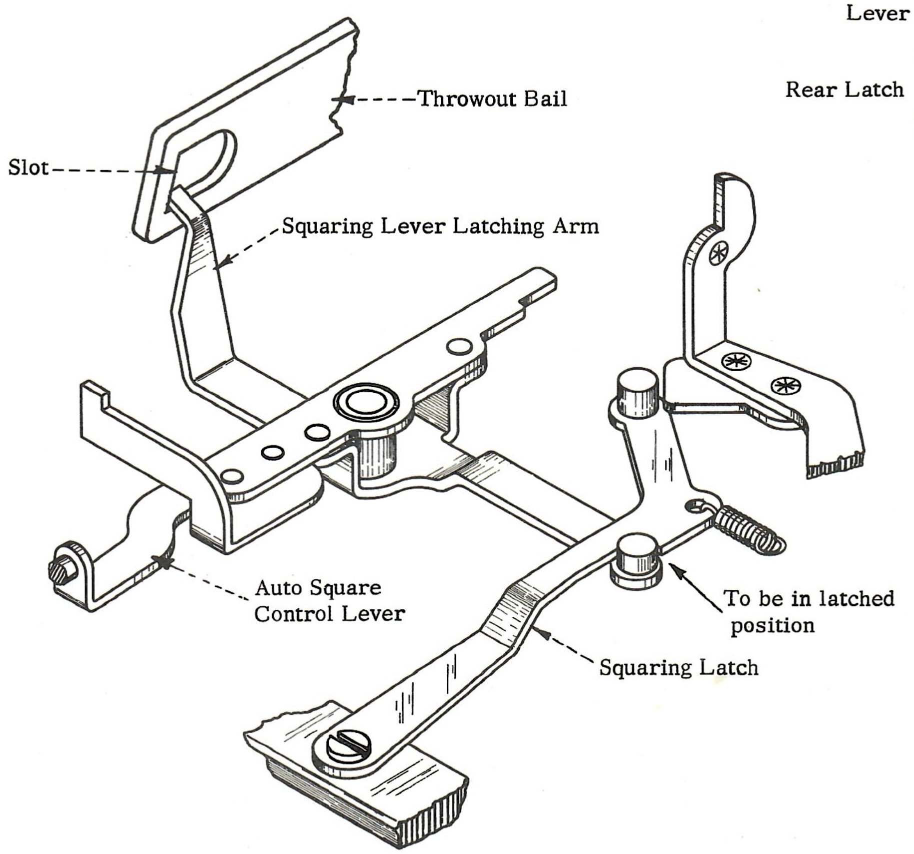
FIG. B

3. As the high lobe on the unit release cam contacts the roller on the unit release cam follower arm, the unit release latch is relatched.

4. The mult correction restore cam engages the restore segment and causes the restore bail to rotate against the segments to insure that all segments are latched.

UNIT SHIFT TO HOME POSITION: (Cont'd.)




Throwout Bail
Slot
Squaring Lever Latching Arm
Auto Square Control Lever
To be in latched position
Squaring Latch

5. The slot in the throwout bail to contact the tail on the squaring lever latching arm and overlatch the squaring latch to insure that the auto squaring control lever is in the latched position.

6. The power set shift lever to raise, so the rear latch and front latch can move under the power set lever. When the power set lever restores, all the parts positioned by it will be returned to home position.

As the drive shaft completes its cycle, the keyboard is cleared, the adjustment arm is relatched onto the shift shaft latch, the clutch is disengaged and the switch opened to stop the drive shaft.